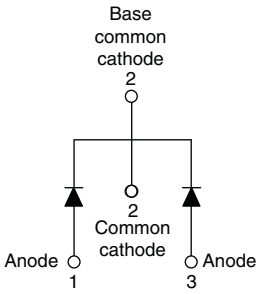
## Ultrafast Rectifier, 16 A FRED Pt®

TO-220AB




### FEATURES

- Ultrafast recovery time
- Low forward voltage drop
- 175 °C operating junction temperature
- Low leakage current
- Designed and qualified for industrial level
- Material categorization:
  for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

e3

RoHS COMPLIANT

| PRODUCT SUMMARY | |
|---|---|
| Package | TO-220AB |
| $I_{F(AV)}$ | 2 x 8 A |
| $V_R$ | 400 V |
| $V_F$ at $I_F$ | 0.94 V |
| $t_{rr}$ typ. | See Recovery table |
| $T_J$ max. | 175 °C |
| Diode variation | Common cathode |

### DESCRIPTION/APPLICATIONS

FRED Pt® series are the state of the art ultrafast recovery rectifiers specifically designed with optimized performance of forward voltage drop and ultrafast recovery time.

The planar structure and the platinum doped life time control, guarantee the best overall performance, ruggedness and reliability characteristics.

These devices are intended for use in the output rectification stage of SMPS, UPS, DC/DC converters as well as freewheeling diode in low voltage inverters and chopper motor drives.

Their extremely optimized stored charge and low recovery current minimize the switching losses and reduce over dissipation in the switching element and snubbers.

| ABSOLUTE MAXIMUM RATINGS | | | | | |
|---|---|---|---|---|---|
| PARAMETER | | SYMBOL | TEST CONDITIONS | VALUES | UNITS |
| Peak repetitive reverse voltage | | $V_{RRM}$ | | 400 | V |
| Average rectified forward current | per leg | $I_{F(AV)}$ | | 8 | A |
| | total device | | $T_C$ = 155 °C, rated $V_R$ | 16 | |
| Non-repetitive peak surge current | | $I_{FSM}$ | $T_C$ = 25 °C | 100 | |
| Peak repetitive forward current | | $I_{FRM}$ | $T_C$ = 155 °C, rated $V_R$, square wave, 20 kHz | 16 | |
| Operating junction and storage temperatures | | $T_J$, $T_{Stg}$ | | -65 to +175 | °C |

| ELECTRICAL SPECIFICATIONS PER LEG ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Breakdown voltage, blocking voltage | $V_{BR}$, $V_R$ | $I_R$ = 100 µA | 400 | - | - | V |
| Forward voltage | $V_F$ | $I_F$ = 8 A | - | 1.19 | 1.3 | |
| | | $I_F$ = 8 A, $T_J$ = 150 °C | - | 0.94 | 1.0 | |
| Reverse leakage current | $I_R$ | $V_R$ = $V_R$ rated | - | 0.2 | 10 | µA |
| | | $T_J$ = 150 °C, $V_R$ = $V_R$ rated | - | 20 | 500 | |
| Junction capacitance | $C_T$ | $V_R$ = 400 V | - | 14 | - | pF |
| Series inductance | $L_S$ | Measured lead to lead 5 mm from package body | - | 8.0 | - | nH |

| DYNAMIC RECOVERY CHARACTERISTICS PER LEG ($T_J$ = 25 °C unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNITS |
| Reverse recovery time | $t_{rr}$ | $I_F$ = 1.0 A, $dI_F/dt$ = 50 A/μA, $V_R$ = 30 V | | - | 35 | 60 | ns |
| | | $T_J$ = 25 °C | $I_F$ = 8 A<br>$dI_F/dt$ = 200 A/μs<br>$V_R$ = 200 V | - | 43 | - | |
| | | $T_J$ = 125 °C | | - | 67 | - | |
| Peak recovery current | $I_{RRM}$ | $T_J$ = 25 °C | | - | 2.8 | - | A |
| | | $T_J$ = 125 °C | | - | 6.3 | - | |
| Reverse recovery charge | $Q_{rr}$ | $T_J$ = 25 °C | | - | 60 | - | nC |
| | | $T_J$ = 125 °C | | - | 210 | - | |

| THERMAL MECHANICAL SPECIFICATIONS | | | | | | | |
|---|---|---|---|---|---|---|---|
| PARAMETER | | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Maximum junction and storage temperature range | | $T_J$, $T_{Stg}$ | | -65 | - | 175 | °C |
| Thermal resistance, junction to case | per leg | $R_{thJC}$ | | - | 3.6 | 4 | °C/W |
| | per device | | | - | 1.8 | 2 | |
| Thermal resistance, junction to ambient | | $R_{thJA}$ | Typical socket mount | - | - | 50 | |
| Thermal resistance, case to heatsink | | $R_{thCS}$ | Mounting surface, flat, smooth and greased | - | 0.5 | - | |
| Weight | | | | - | 2.0 | - | g |
| | | | | - | 0.07 | - | oz. |
| Mounting torque | | | | 6.0 (5.0) | - | 12 (10) | kgf · cm (lbf · in) |
| Marking device | | | Case style TO-220AB | 16CTU04 | | | |

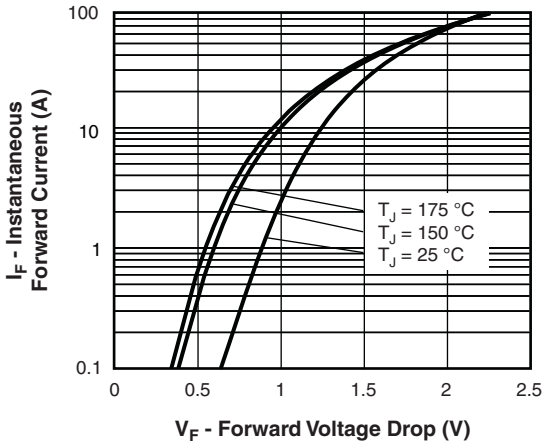



Fig. 1 - Typical Forward Voltage Drop Characteristics

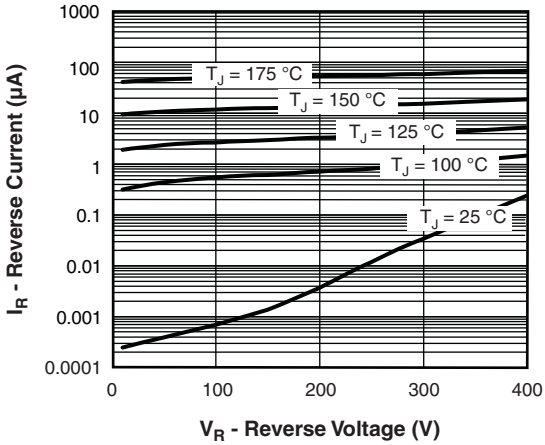



Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

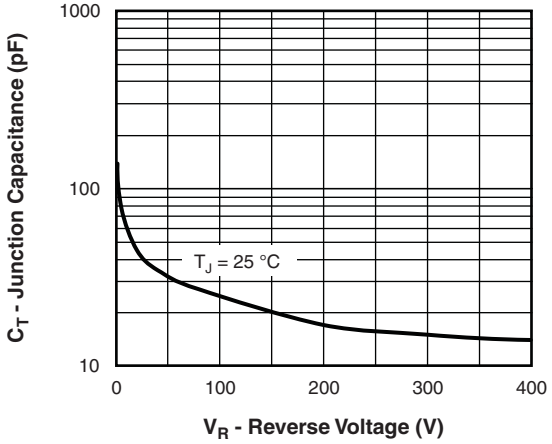



Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

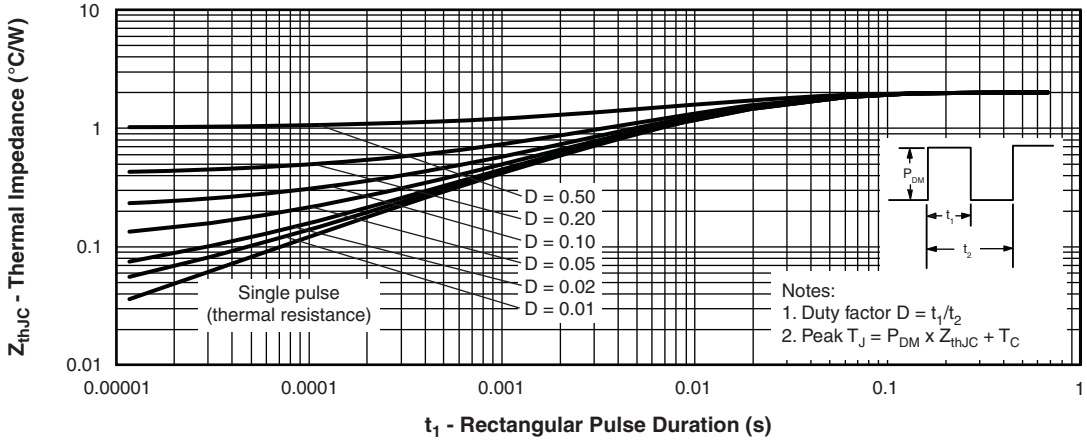



Fig. 4 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics

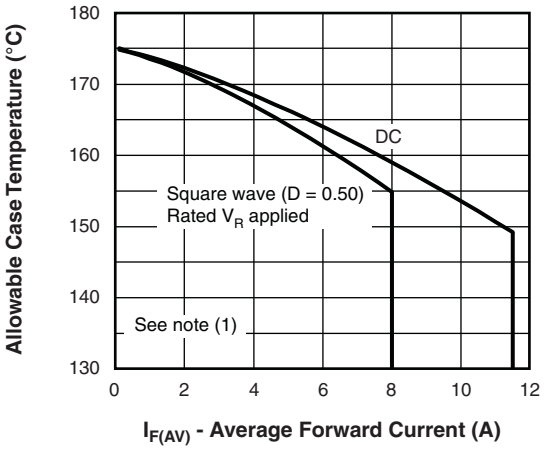



Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current

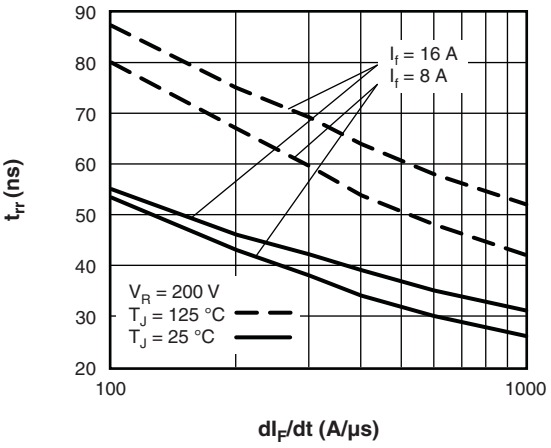



Fig. 7 - Typical Reverse Recovery Time vs. $dI_F/dt$

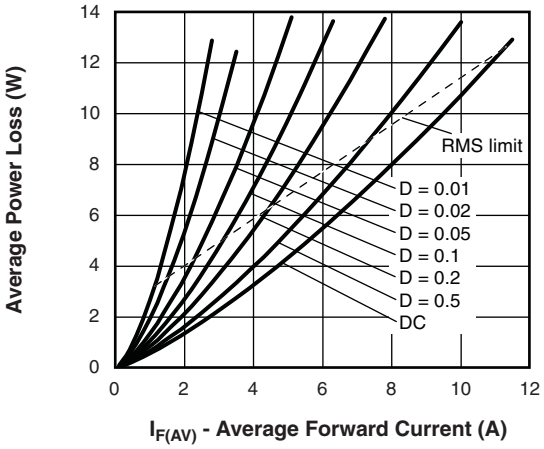



Fig. 6 - Forward Power Loss Characteristics

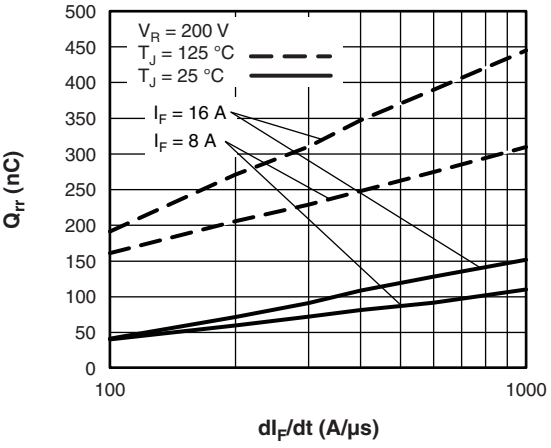



Fig. 8 - Typical Stored Charge vs. $dI_F/dt$

**Note**

(1) Formula used: $T_C = T_J - (Pd + Pd_{REV}) \times R_{thJC}$;
Pd = Forward power loss = $I_{F(AV)} \times V_{FM}$ at ($I_{F(AV)}$/D) (see fig. 6);
$Pd_{REV}$ = Inverse power loss = $V_{R1} \times I_R (1 - D)$; $I_R$ at $V_{R1}$ = Rated $V_R$

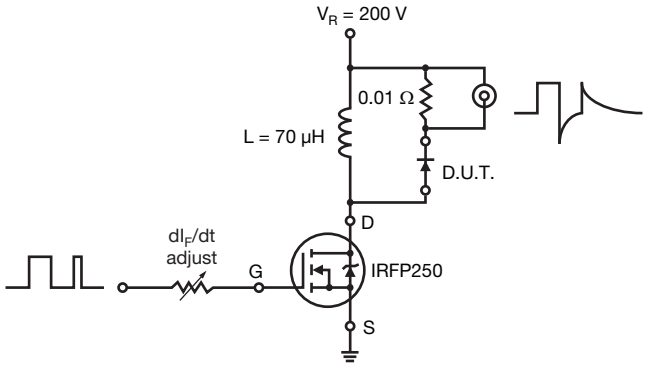
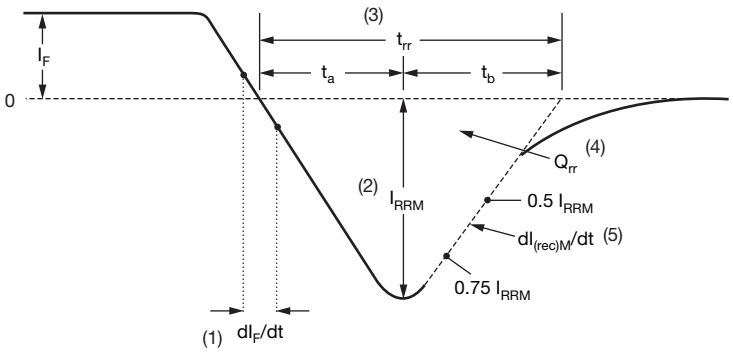



Fig. 9 - Reverse Recovery Parameter Test Circuit




(1) $dI_F/dt$ - rate of change of current through zero crossing

(2) $I_{RRM}$ - peak reverse recovery current

(3) $t_{rr}$ - reverse recovery time measured from zero crossing point of negative going $I_F$ to point where a line passing through 0.75 $I_{RRM}$ and 0.50 $I_{RRM}$ extrapolated to zero current.

(4) $Q_{rr}$ - area under curve defined by $t_{rr}$ and $I_{RRM}$

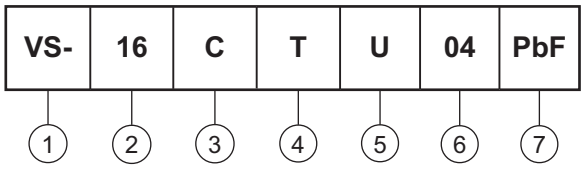
$$Q_{rr} = \frac{t_{rr} \times I_{RRM}}{2}$$

(5) $dI_{(rec)M}/dt$ - peak rate of change of current during $t_b$ portion of $t_{rr}$

Fig. 10 - Reverse Recovery Waveform and Definitions

## ORDERING INFORMATION TABLE

Device code



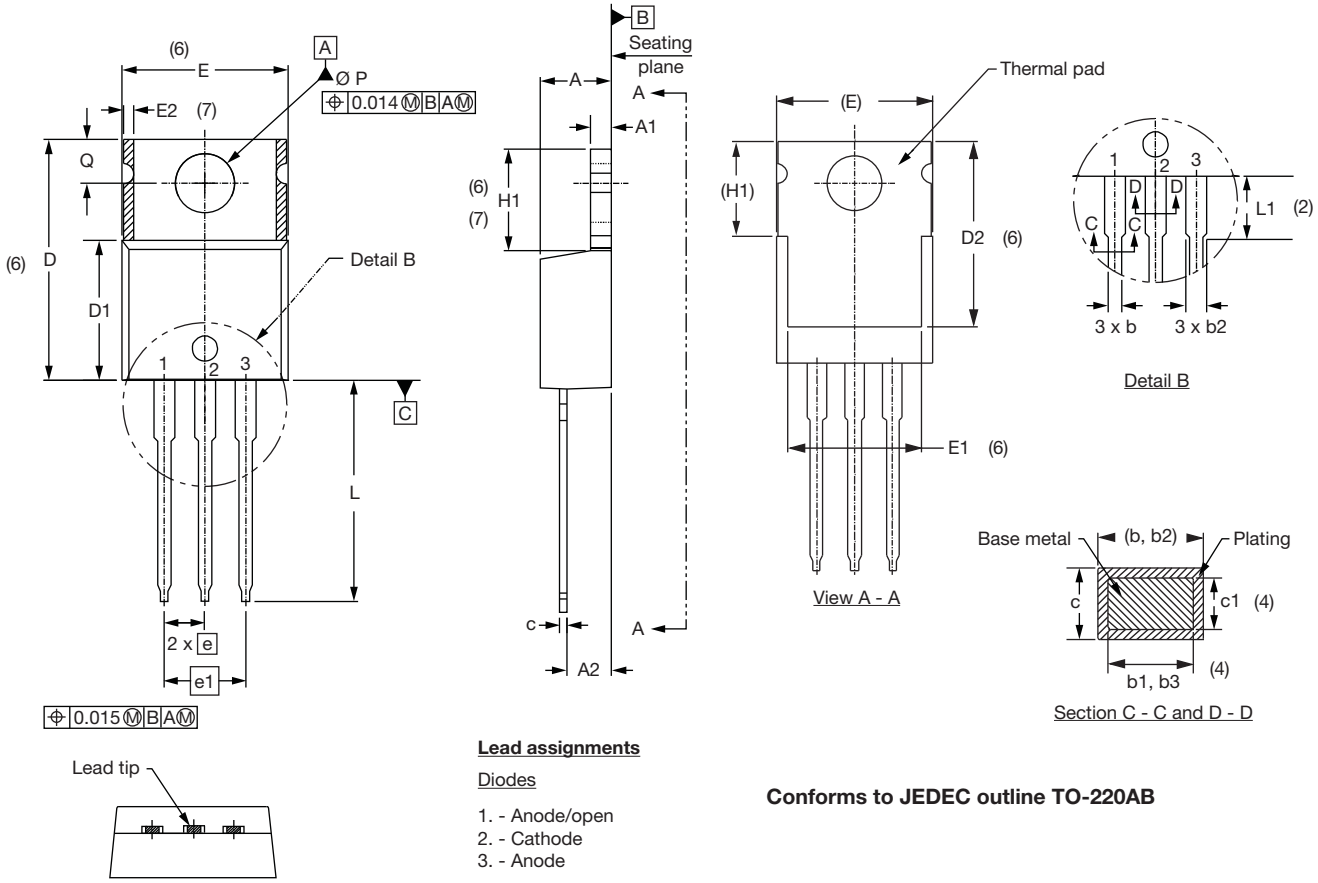

1 - Vishay Semiconductors product
2 - Current rating (16 = 16 A)
3 - Circuit configuration:
C = common cathode
4 - Package:
T = TO-220
5 - Ultrafast recovery
6 - Voltage rating (04 = 400 V)
7 - Environmental digit:
PbF = lead (Pb)-free and RoHS-compliant
-N3 = halogen-free, RoHS-compliant and totally lead (Pb)-free

| **ORDERING INFORMATION** (Example) | | | |
|---|---|---|---|
| **PREFERRED P/N** | **QUANTITY PER T/R** | **MINIMUM ORDER QUANTITY** | **PACKAGING DESCRIPTION** |
| VS-16CTU04PbF | 50 | 1000 | Antistatic plastic tube |
| VS-16CTU04-N3 | 50 | 1000 | Antistatic plastic tube |

| **LINKS TO RELATED DOCUMENTS** | | |
|---|---|---|
| Dimensions | | www.vishay.com/doc?95222 |
| Part marking information | TO-220ABPbF | www.vishay.com/doc?95225 |
| | TO-220AB-N3 | www.vishay.com/doc?95028 |

# TO-220AB

**DIMENSIONS** in millimeters and inches




Lead tip



**Lead assignments**

Diodes

1. - Anode/open
2. - Cathode
3. - Anode

**Conforms to JEDEC outline TO-220AB**

| SYMBOL | MILLIMETERS | | INCHES | | NOTES |
|---|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.25 | 4.65 | 0.167 | 0.183 | |
| A1 | 1.14 | 1.40 | 0.045 | 0.055 | |
| A2 | 2.56 | 2.92 | 0.101 | 0.115 | |
| b | 0.69 | 1.01 | 0.027 | 0.040 | |
| b1 | 0.38 | 0.97 | 0.015 | 0.038 | 4 |
| b2 | 1.20 | 1.73 | 0.047 | 0.068 | |
| b3 | 1.14 | 1.73 | 0.045 | 0.068 | 4 |
| c | 0.36 | 0.61 | 0.014 | 0.024 | |
| c1 | 0.36 | 0.56 | 0.014 | 0.022 | 4 |
| D | 14.85 | 15.25 | 0.585 | 0.600 | 3 |
| D1 | 8.38 | 9.02 | 0.330 | 0.355 | |
| D2 | 11.68 | 12.88 | 0.460 | 0.507 | 6 |

| SYMBOL | MILLIMETERS | | INCHES | | NOTES |
|---|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. | |
| E | 10.11 | 10.51 | 0.398 | 0.414 | 3, 6 |
| E1 | 6.86 | 8.89 | 0.270 | 0.350 | 6 |
| E2 | - | 0.76 | - | 0.030 | 7 |
| e | 2.41 | 2.67 | 0.095 | 0.105 | |
| e1 | 4.88 | 5.28 | 0.192 | 0.208 | |
| H1 | 6.09 | 6.48 | 0.240 | 0.255 | 6, 7 |
| L | 13.52 | 14.02 | 0.532 | 0.552 | |
| L1 | 3.32 | 3.82 | 0.131 | 0.150 | 2 |
| Ø P | 3.54 | 3.73 | 0.139 | 0.147 | |
| Q | 2.60 | 3.00 | 0.102 | 0.118 | |
| θ | 90° to 93° | | 90° to 93° | | |

**Notes**

(1) Dimensioning and tolerancing as per ASME Y14.5M-1994
(2) Lead dimension and finish uncontrolled in L1
(3) Dimension D, D1 and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body
(4) Dimension b1, b3 and c1 apply to base metal only
(5) Controlling dimensions: inches
(6) Thermal pad contour optional within dimensions E, H1, D2 and E1
(7) Dimensions E2 x H1 define a zone where stamping and singulation irregularities are allowed
(8) Outline conforms to JEDEC TO-220, except A2 (maximum) and D2 (minimum) where dimensions are derived from the actual package outline

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